

Oh, to be a child in America: Morning cartoons with a breakfast of sugar-coated cereal, hours on the sofa munching chips and playing video games, matinee movies enjoyed with mega-sized servings of soda and popcorn, frozen dinners followed by more hours surfing computer chat rooms, and finally bed. In all, this combination of inactivity and gluttonous feeding, which is shared by millions of American children, fuels one of the country's most alarming pediatric problems: obesity.

According to *America's Children: Key National Indicators of Well-Being 2003*, issued in July 2003 by the Federal Interagency Forum on Child and Family Statistics, the number of overweight and obese children in the United States has more than doubled in the last two decades.

Donna Day/Stone



OBESITY



A Weighty Issue for Children

Overweight and obesity are defined, respectively, as being in the 85th and 95th percentiles for body mass index (BMI—the ratio of weight in kilograms to height in meters squared) for age and sex based on nationally representative survey data. Today, 15% of all children aged 6–18 exceed the upper range of healthy weights for their age groups. Among black and Hispanic children, the number leaps to an average of 26%.

Obesity can be a dangerous childhood hazard. According to Stephen Daniels, a professor of pediatrics and environmental health at Children's Hospital Medical Center in Cincinnati, many overweight and obese children suffer a range of debilitating health problems such as type 2 diabetes mellitus (which has increased more than 10-fold in children since 1982), sleep apnea, hypertension, and cardiovascular disease, in addition to low self-esteem and depression. Data published in the August 2003 issue of *Archives of Pediatrics & Adolescent Medicine* by the American Academy of Pediatrics (AAP) Center for Child Health Research further indicate that nearly 1 million obese U.S. children suffer from a condition called metabolic syndrome. This syndrome, which makes children unusually prone to type 2 diabetes and premature heart disease, is characterized by the presence of at least five criteria: excessive abdominal fat, high blood pressure, high triglyceride levels in blood, low levels of "good" HDL cholesterol, and high blood sugar.

Daniels adds that childhood obesity also exacerbates the risk of potentially fatal health problems later in life. For instance, he says, obese children have been observed during autopsy to have higher levels of atherosclerotic plaque, which is a risk factor for stroke and myocardial infarction. "Another big problem with obese children is non-alcoholic fatty liver disease," Daniels says. "This can promote nonalcoholic hepatitis, fibrosis, and ultimately liver sclerosis in some adult patients."

In the long run, says Daniels, obese children are much more likely to become obese adults, and "we are finding that childhood risk factors can be linked to the incidence of adult disease." Many of obesity's associated

health problems—diabetes in particular—also become more difficult to manage in older patients.

The problem is by no means limited to the United States. The World Health Organization (WHO) calls childhood obesity a global epidemic that is spreading into the developing world. A report by Harvard endocrinology professor David S. Ludwig and colleagues in the 10 August 2002 issue



Global obsession. Obesity is fast becoming a worldwide problem. Some countries, such as China, are fighting back with exercise programs designed especially to prevent childhood obesity.

of *The Lancet* cited rates that have increased nearly threefold over 10 years in England and nearly fourfold over 18 years in Egypt. Substantial increases have also been detected in Brazil, Ghana, Chile, Morocco, China, and Haiti, among other countries.

Experts blame the worldwide epidemic on the growing availability of energy-dense processed foods and declining physical activity—a combination for which humans, whose biology evolved in times of frequent famine, are genetically unprepared. "The

way I like to couch it is that we have a mismatch between our genes and the environment," explains James Hill, director of the Center for Human Nutrition at the University of Colorado Health Sciences Center in Denver. "Our ancestors had to expend a lot of energy just to get through the day. So, our genes say, 'Eat when food is available, and rest when you don't have to be active.' But now, [in many places] food is always available, and technology has made it easy to be sedentary. So it's really the environment that's causing the problem."

Researchers who try to pinpoint the specific causes of obesity or quantify the proportional contribution of causes to the obesity epidemic face a tough challenge. It is nearly impossible to definitively link assumed risk factors with the growth of obesity in the population. Researchers can say, for instance, that obesity rates have risen along with suburban sprawl, video games, and super-sized fast-food portions, but they can't say that sprawl, video games, or fast food cause obesity. In general, children become obese for highly individualized reasons. A child who spends hours per day watching television but eats sparingly, for instance, might well still be underweight for his age. In population terms, the epidemic appears to be the result of many interrelated factors, each exacerbating the obesity-promoting effects of the others.

Existing data do suggest that children on the whole are growing more sedentary. For instance, according to the Centers for Disease Control and Prevention (CDC), the number of children who attend daily physical education classes declined from 18.3% in 1995 to 12% in 2001. In its 2003 policy statement on improving the health of all children, the AAP reported that 20% of U.S. children aged 8–16 engage in two or fewer stints of physical activity per week. The AAP also reported that 25% of children watch four or more hours of television per day. These children have a significantly greater BMI than children who watch two hours or less per day.

Obesity and the Built Environment

The influence of the physical or "built" environment on human activity and obesity is

a new area of study that is just now getting off the ground. After decades of rampant low-density growth, much of the American landscape has been transformed into a sea of strip malls and fast-food restaurants. Within these areas, schools, shops, and other services are separated by miles of pavement, much of it hostile to cyclists and pedestrians.

As sprawl spreads throughout the nation, Americans drive more and walk less. According to the 2001 Department of Transportation National Household Travel Survey, the total number of "walking trips" that Americans make on a typical day has declined by 40% since 1977. Today, 90% of all trips made by adults and 70% of all trips made by children are in cars. Furthermore, children's walking trips have declined by 60% since 1977, and walking and bicycling trips to school have declined by one-half since 1969.

These data may be eye-catching, but what do they say about changing activity patterns, let alone obesity? Just because children spend more time in cars, does that necessarily mean they exercise less? Scientists admit they're not sure. "We do not have any good data that actually document a decline in kids' physical activity," says James Sallis, a professor of psychology at San Diego State University. "This is a real shame. We just have to infer it from societal trends." Sallis heads Active Living Research, a \$12.5 million national program of the Robert Wood Johnson Foundation, created to study environmental influences on activity and health.

Making inferences about childhood activity with the available data isn't easy. For instance, the National Household Travel Survey records bicycle use, but only for transportation, and mainly for adults. Likewise, public health surveys such as the CDC Behavioral Risk Factor Surveillance System address walking and bicycling, but

only as leisure activities. Linking transportation and leisure data sets is challenging because the measurement units are incompatible, adds Phil Bors, a project officer with Active Living by Design, a Robert Wood Johnson Foundation research program based at the University of North Carolina at Chapel Hill. Transportation data are recorded in units of "trips," whereas public health data are

But some links between activity and the built environment have been established. "Three elements of the built environment that really seem to influence activity levels are perceptions of safety, good lighting, and the availability of sidewalks," says Barbara Ainsworth, who chairs the Department of Exercise and Nutritional Sciences at San Diego State University. In most cases, however, these relationships pertain to adults. It's hard to extrapolate these results to children, says Ainsworth, and the data on children are very rare.

Susan Handy, an associate professor of environmental science and policy at the University of California, Davis, confirmed in the August 2002 supplement to the *American Journal of Preventive Health* that walkers and cyclists tend to be influenced in their travel decisions by neighborhood factors such as safety, comfort, and aesthetics, whereas drivers typically are not. Urban planning studies such as Handy's show that people are more likely to walk and bicycle in traditional communities populated by nearby shops and services. Those who live in more modern, "auto-dependent" communities are more likely to drive.

Ross Brownson, an epidemiologist at St. Louis University, published evidence in the December 2001 *American Journal of Public Health* showing that people's activity levels increased when they lived close to walking trails, swimming pools, and gyms. Similarly, in one study that did pertain specifically to children, published in *Health*

Psychology in September 1993, Sallis found that activity levels among 4-year-old children correlated highly with the amount of time they spent outdoors and their access to recreational areas such as playgrounds, parks, and yards.

Data that link the built environment specifically to obesity are only now beginning to emerge. In the September/October



Swing shift. Although studies suggest that living near parks and playgrounds enhances children's likelihood of being active, physical activity among school-age children has dropped off sharply in recent years.

recorded in minutes of activity.

The CDC National Health and Nutrition Examination Survey, a key source of U.S. body weight data, provides no contextual information about physical environments in which obese Americans live, and even fewer data connecting walking or bicycling with health indicators and demographics, Bors says.

Our ancestors had to expend a lot of energy just to get through the day. . . But now, [in many places] food is always available, and technology has made it easy to be sedentary. So it's really the environment that's causing the problem.

—James Hill
Center for Human Nutrition, University of
Colorado Health Sciences Center



2003 issue of the *American Journal of Health Promotion*, Reid Ewing, a research professor at the University of Maryland National Center for Smart Growth Research and Education, and colleagues from the CDC and Rutgers University published the first national study relating the physical environments in which people live to their activity levels, weight, and health. This study compared health and obesity statistics from the Behavioral Risk Factor Surveillance System (which limits its analyses to adults) to county-specific “sprawl indices” for 488 counties in the United States. These indices, based on data obtained from the U.S. Census Bureau and other sources, indicated which areas were the most spread out with the fewest safe walking and biking routes.

The study found that weight and hypertension levels rose as suburban densities fell. More specifically, Ewing found that adults who lived in the most sprawling counties, as defined by the sprawl index, weighed on average up to six pounds more than people in the most compact counties, even after controlling for age, education, gender, race, and ethnicity. Don Chen, executive director of Smart Growth America, a Washington, D.C.-based outreach organization that cosponsored the study, says, “We have every reason to assume the same relationship can be found among children.”

Unpublished data gathered recently by Sallis and his graduate student, pediatrician Mort Kligerman, indicate that community designs influence activity levels among adolescents. Sallis and Kligerman outfitted a group of 100 adolescents with motion sensors and tracked them for seven days in a range of suburban environments. This study, the first of its kind, found that activity levels increased with the overall “walkability” of the neighborhoods where the children lived. More specifically, residential density (measured in houses per

acre), street connectivity, and mixed uses characterized by nearby schools, stores, and businesses all positively enhanced overall activity scores. “So, this is good news,” Sallis says. “It’s the first inkling we have that community designs relate to the physical activity of adolescents.”

Research programs focused specifically on the built environment and its role in childhood obesity have only recently begun to emerge, and their specific goals and objectives

are still being developed. The NIEHS is investigating the built environment as part of a broader NIH task force on obesity being coordinated by the National Institute of Diabetes and Digestive and Kidney Diseases. Allen Dearth, the NIEHS associate director for Research Coordination, Planning, and Translation, says a research strategy addressing obesity represents a new direction for the institute, which previously has looked into how the built environment influences other pediatric health problems, such as asthma and lead poisoning. According to Dearth, the chief goal of the NIEHS is to study the advantages of a better built environment on childhood health. “Our focus on obesity is part of that,” he says.

The Institute of Medicine is currently involved in two major studies that address the role of the built environment in childhood obesity. One, titled *Prevention of Obesity in Children and Youth*, is addressing the built environment as part of a multiplicity of obesity risk factors. The other, undertaken in conjunction with the National Academy of Sciences Transportation Research Board and titled *Physical Activity, Health, Transportation, and Land Use*, is addressing how transportation and land use patterns contribute to sedentary behavior. Referring to these studies, Linda Meyers, a National Academy of Sciences project coordinator, says, “Expert committees are addressing, deliberating, and discussing the various issues. A report should be expected in the fall of 2004.”

Fast Food, Nutrition, and Portion Sizes

If the built environment’s role in childhood obesity seems complicated, dietary factors in



Islands of isolation. Suburban sprawl has created communities where it can be difficult to walk, which may be contributing to more isolated and sedentary childhoods.

Top to bottom: Photodisc; Photodisc

relation to the epidemic are no less so. Nearly every aspect of the dietary contribution is debated, including the role of fats in the diet and the fundamental issue of daily caloric intake. Some scientists lay the blame for obesity squarely on declining activity, insisting that caloric intake has remained stable over time, while others, such as Barbara Rolls, Guthrie Chair in the Department of Nutritional Sciences at The Pennsylvania State University, say it has not.

Part of the problem, Rolls says, is that trend estimates for caloric intake are based on self-reported data, which are subjective and easily criticized by special interests, including the food industry, which is increasingly under attack by those who blame it for rising weight and health problems. "It's a shame that we don't have stronger data," she says. "But it's tough to get people to tell you what they eat."

Rolls believes the population's intake of calories is probably rising. At a minimum, the energy equation between caloric intake and expenditure is, she says, "out of whack." Says Rolls, "We are eating more calories than we need and also exercising less. So, the equation is unbalanced on both sides, which makes it really bad."

A key issue is the body's exquisite sensitivity to fluctuations in the energy balance. A positive energy balance—or extra caloric intake—of just 120 calories per day, equal to about one serving of soda, could produce a 50-kilogram (110-pound) increase in body weight over 10 years. In the 17 February 2001 issue of *The Lancet*, Ludwig and colleagues reported that each additional daily serving of soda increases the risk of childhood obesity by 60%, after controlling for exercise and diet.

Rolls, an expert on the effects of portion size on intake, says that it has become much easier for children and adults alike to get high calorie loads quickly. The real culprits, she says, are energy-dense foods with low fiber content—a dietary universe that includes most of the fast food and processed snacks on the market today. A child who eats a typical fast-food hamburger, fries, and soft drink can consume over 1,200 calories in a single meal, more than half the daily caloric requirement. This tasty meal, which plays to a primordial love of salt, sugar, and fat, is also cheap, which helps to explain why obesity rates are particularly high at the lower end of the socioeconomic spectrum.

Ludwig suggests that one reason people overindulge in these foods is because they have a high glycemic index, meaning they produce a rapid increase in blood sugar. According to Ludwig, the surge in blood glucose and insulin produced by such foods soon crashes and stimulates hunger within a short period. Low-glycemic-index foods such as legumes, fruits, and vegetables, on the other hand, release nutrients more slowly, which leads



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—Eric Schlosser
Fast Food Nation: The Dark Side of the All-American Meal (2002)

to less erratic eating habits. Most low-nutritional-quality snacks and soft drinks have a high glycemic index, and they also are made from cheap ingredients such as sugar and potatoes, and thus are profitable, Ludwig says. "This is why they are pushed so aggressively by food companies, who spend billions a year marketing them to kids," he adds.

According to Rolls's research, portion size also has a significant effect on consumption. In her report in the March/April 2003 issue of *Nutrition Today*, she cited

data indicating that portions in restaurants, grocery products, and even cookbooks have steadily gotten larger since the 1970s, to the extent that they are now sharply dissociated from the serving sizes recommended by the U.S. Department of Agriculture Food Guide Pyramid. In general, she says, the larger the portion, the more people eat.

This appears to be a learned rather than innate behavior. Rolls found that toddlers below the age of 3 self-regulate their food intake and stop eating when full, regardless of how much they are served. As children get older, they adapt to environmental cues urging them to "clean their plate." Eventually, Rolls's research shows, portion size becomes a major determinant of food consumption.

Meanwhile, time-strapped citizens are eating out more than ever, even as portions served in restaurants, movie theaters, and coffee shops have become enormous. This is the era of "huge food," Rolls says: consumers are surrounded by muffins that weigh half a pound, 2-pound bowls of pasta, 1-pound steaks, and "medium" popcorn servings that contain 16 cups and up to 1,000 calories.

In many instances, these mega-servings are the result of overproduction in agriculture; super-sizing is a way for the food industry to make profits on its overproduction. There is also the issue of consumer demand—super-sizing has become an ingrained part of American culture. Says Kari Bjorhus, director of health and nutrition communications for Coca-Cola: "We base our decisions on what consumers tell us. Our research shows us that consumers see value in larger portion sizes."

But do large portions cause obesity? As is often the case with environmental epidemiology, proving causality is next to impossible, Rolls says. "[None-theless], a body of suggestive evidence can be very persuasive," she adds. "So, for example, on portion size I would say the weight of the evidence suggests we need to do something about large portions [even without conducting] a study to see if we can directly fatten people up by serving them large portions!"

The factors driving obesity abroad, where the data are even sparser than in the United States, are likely similar to those driving the U.S. trend. Experts suggest that, as villagers flock to cities in a global surge of urbanization, traditional diets are

giving way to locally available store-bought foods with a higher proportion of saturated fats and sugars.

In many developing countries, obesity levels are rising in tandem with the growth of a fast-food culture imported from the United States. "The growing popularity of fast food is just one of many cultural changes that have been brought about by globalization," wrote Eric Schlosser in his 2002 book *Fast Food Nation: The Dark Side of the All-*

Gene–Environment Interactions in Obesity

One of obesity's more intriguing features is the variability with which it is expressed among different ethnicities and nationalities. For instance, Scandinavian obesity rates are especially low relative to the rest of the world. And South Pacific Islanders, in addition to indigenous populations in Latin America, have rates that are exorbitantly high. Could genetics play

from twin, adoption, and family studies strongly suggests that biological relatives exhibit similarities in the maintenance of body weight. Some children seem to be genetically immune to the effects of overeating. Others continue to gain weight no matter how hard they try to shed the extra pounds.

But these extremes are a genetic minority, Bouchard says. Among most populations, the genetic contributions are graded—some children are more prone toward obesity, others less. The obesity outcome, he explains, becomes manifest only under the right environmental or lifestyle conditions.

Bouchard's research group, which monitors the scientific community's work in this area, publishes an annual update of findings in the journal *Obesity Research*. As of the latest update, he says, researchers had identified a total of 12 genes whose influence on obesity was supported by at least five studies. Candidates include the genes for leptin (a protein hormone that helps regulate metabolism) and its hypothalamic receptor, and the gene for the melanocortin receptor pathway (a hormonal system that plays a role in the regulation of food intake).

However, for all 12 genes there are also negative studies. "Sometimes [the genes] are implicated, and sometimes they are not," Bouchard explains. "When we talk about complex, multifactorial diseases like obesity, it's not surprising that we find discrepancies among studies. There are different groups of genes involved, different populations are studied, and there's a lot of [random variability] in the system. It's hard to tell [correct] studies . . . from those with false positive or false negative results."

According to Bouchard, the strongest evidence to date implicates the genes for leptin and the leptin receptor. Leptin acts through centers in the brain that control feeding, hunger, body temperature, and energy expenditure. Leptin or leptin receptor deficiency is extremely rare, Bouchard says. Only about 12 people in which one of the genes is nonfunctional have been identified so far. All of these individuals were morbidly obese.

Beyond Obesity

Today, obesity is catching up with smoking as a leading cause of illness and death. The costs to society for treatment of obesity and its related conditions, already in the billions of dollars, are sure to increase in the future unless steps to curb the epidemic are successful.



The Effects of Too Much Fat

Obesity can cause serious childhood disease. Childhood obesity is also linked with the incidence of certain adult diseases later in life. Currently, obesity-associated health care costs account for approximately 7% of national health care expenditures. Some of the effects of too much fat include:

- Type 2 diabetes mellitus
- Asthma
- Sleep apnea
- Hypertension
- Cardiovascular disease
- Kidney disease
- Nonalcoholic fatty liver disease
- Osteoarthritis
- Cancer
- Depression and other psychosocial disorders

American Meal. "[I]t seems wherever America's fast-food chains go, waistlines start expanding."

According to Ludwig and colleagues in their 10 August 2002 *Lancet* article, childhood obesity is most common in developing nations among the upper socioeconomic classes, probably owing to the adoption of an increasingly Western lifestyle that includes consumption of fast food. In more-developed countries, obesity predominates in the lower classes, because it is driven in part by low-cost foods of poor nutritional value.

a role? Claude Bouchard, executive director of the Pennington Biomedical Research Center in Baton Rouge, Louisiana, and an expert on the genetics of obesity, says it's possible that some populations may be genetically more predisposed to obesity than others, but there is "absolutely no scientific evidence to support the contention."

The general consensus among experts is that genetic factors do modulate environmental risks for obesity. According to Claudio Maffei, a professor of pediatrics at the University of Verona in Italy, evidence



The family that eats together . . . Genetic links to obesity are still sketchy, but the current evidence strongly suggests that biological relatives are similar in how they maintain body weight.

Around the country, a range of public health programs are working to increase education about obesity and promote efforts to slow its growth. Project SPARK,

coordinated by Sallis and Active Living Research, has developed age-specific school-based approaches that seek to build motor coordination among children from

prekindergarten through middle school to bolster self-esteem and interest in physical activity. The program for younger children also emphasizes building children's social skills in a physical education environment, for example by teaching them to share equipment and cooperate.

"We need programs in schools that help kids learn how to make healthful choices in physical activity and nutrition," Sallis says. "Furthermore, there is no excuse for selling and serving foods of limited nutritional value in schools, but it is done everywhere. Financial support for school food services needs to be increased so they can afford to provide healthful foods to kids."

Hill adds that the first step for clinicians should be to shift the emphasis away from weight loss to a cessation of weight gain. "Small changes—eating a bit less, walking a bit more—can stop weight gain and produce an enormous public health benefit," he says. "Our priorities are in the wrong place right now. We're focusing on obese people and trying to make them lean. We need to focus all our efforts on stopping weight gain."

Charles W. Schmidt